

DR



DeepRob

Discussion 4

Overview of Final Project Topics

University of Michigan and University of Minnesota

Science Robotics

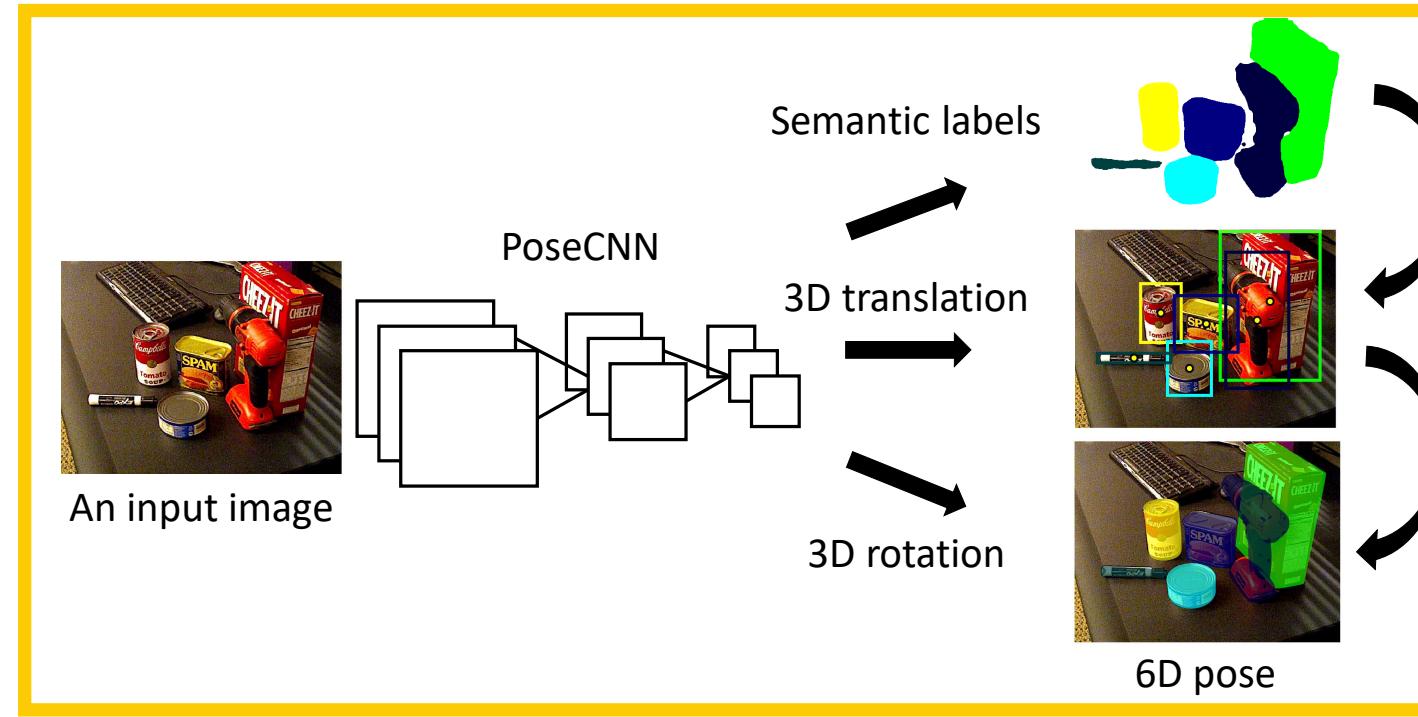
IEEE
**ROBOTICS &
AUTOMATION LETTERS**
A PUBLICATION OF THE IEEE ROBOTICS & AUTOMATION SOCIETY

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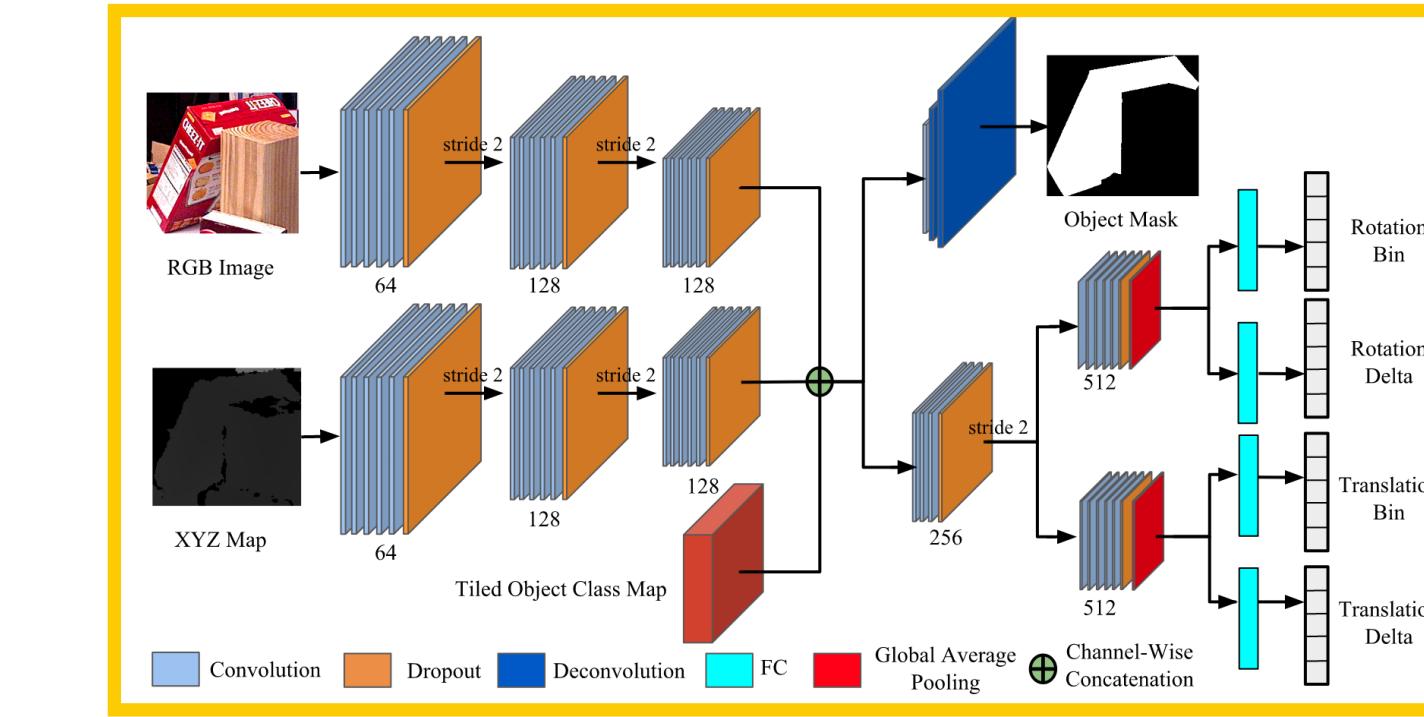
RGB-D Architectures

PoseCNN



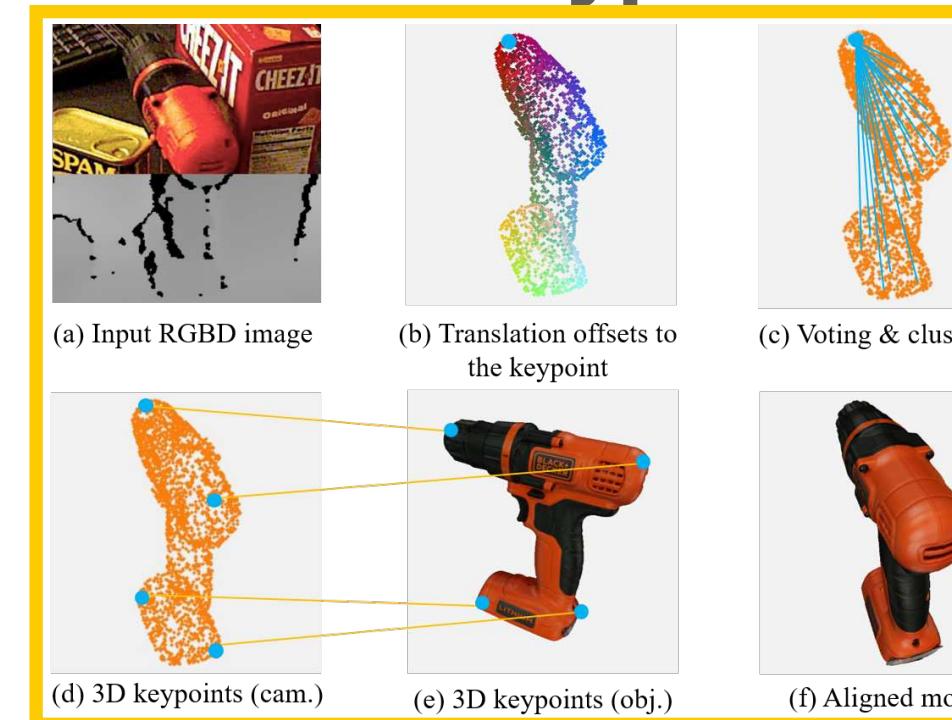
[1] Xiang et al., RSS 2018

Unified Multi-Class Pose Estimation



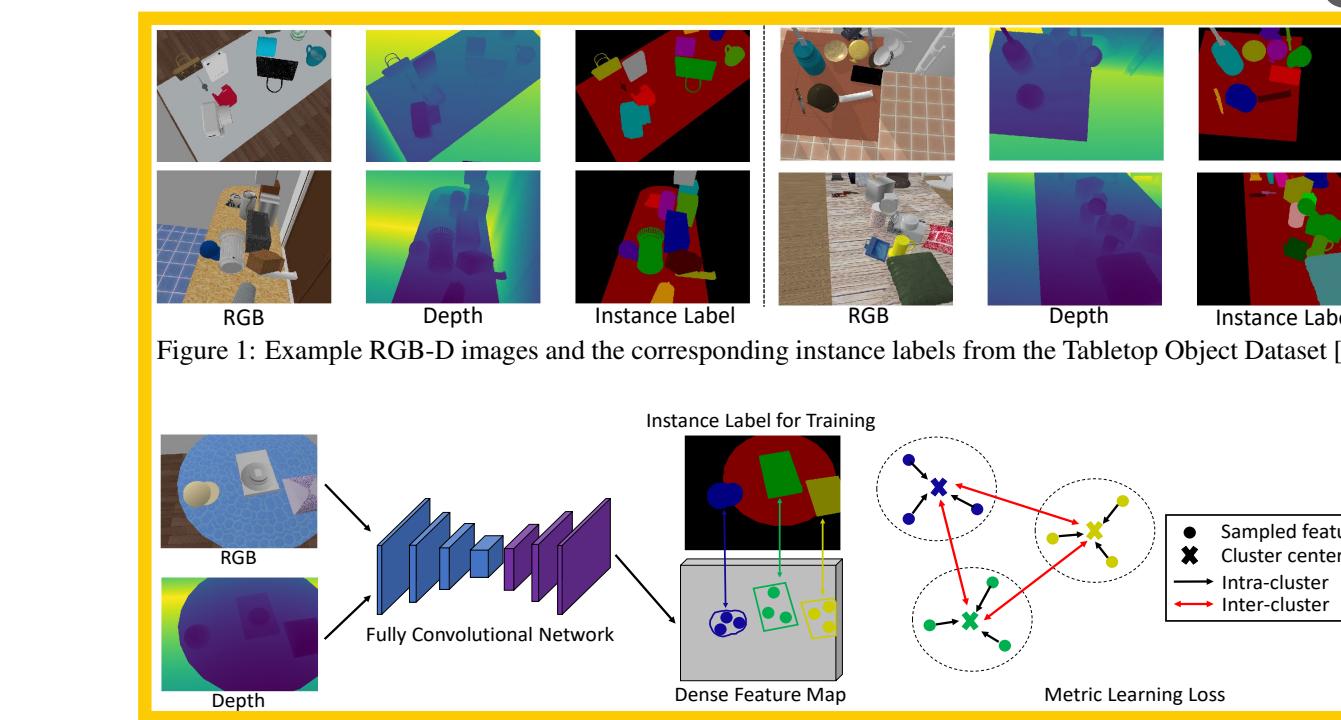
[2] Li et al., ECCV 2018

PVN3D: 3D Keypoint Voting



[3] Xiang et al., CoRL 2021

RGB-D Feature Embeddings



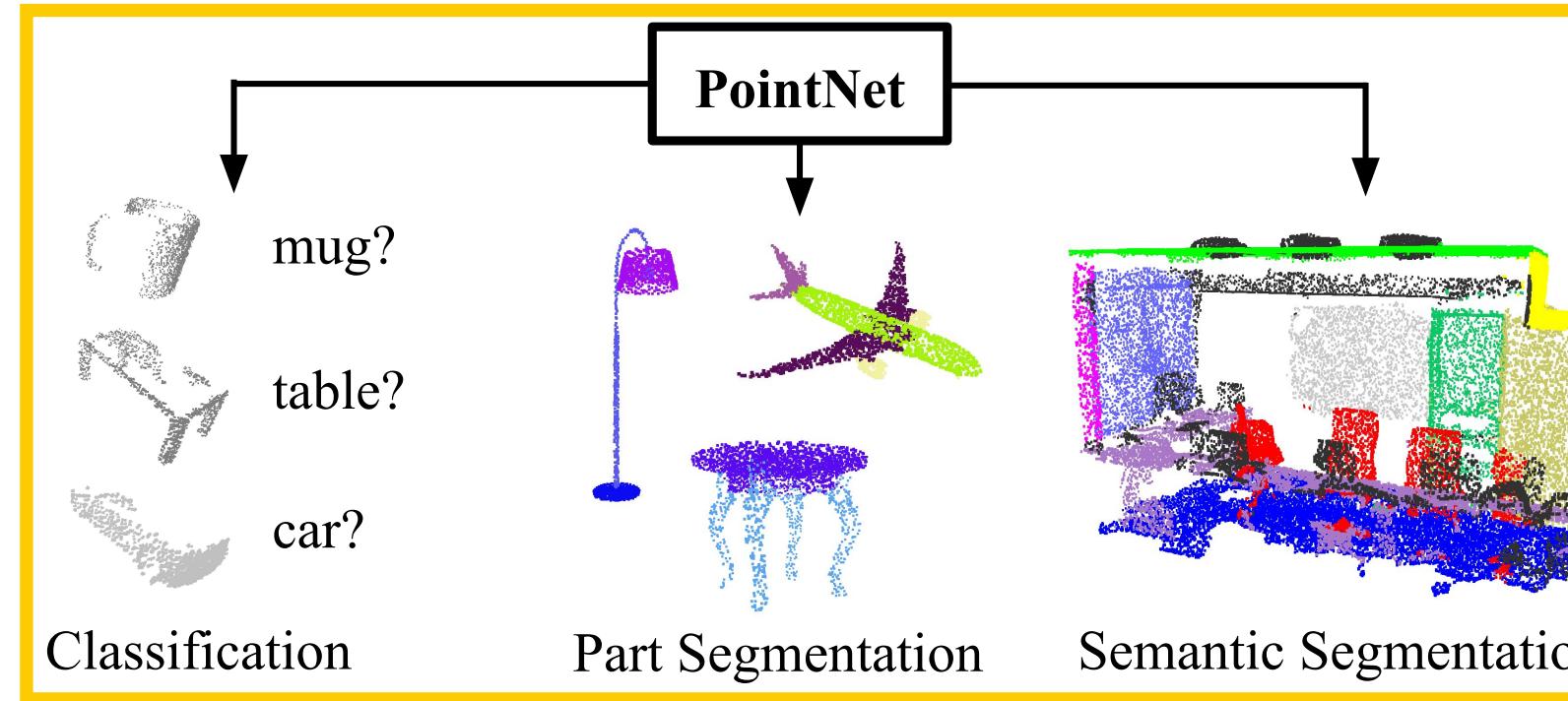
[4] Xiang et al., CoRL 2021

- [1] Yu Xiang, Tanner Schmidt, Venkatraman Narayanan, Dieter Fox. "PoseCNN: A Convolutional Neural Network for 6D Object Pose Estimation in Cluttered Scenes" RSS, 2018.
- [2] Chi Li, Jin Bai, Gregory D. Hager. "A Unified Framework for Multi-View Multi-Class Object Pose Estimation" ECCV, 2018.
- [3] Yisheng He, Wei Sun, Haibin Huang, Jianran Liu, Haoqiang Fan, Jian Sun. "PVN3D: A Deep Point-wise 3D Keypoints Voting Network for 6DoF Pose Estimation" CVPR, 2020.
- [4] Yu Xiang, Christopher Xie, Arsalan Mousavian, Dieter Fox. "Learning RGB-D Feature Embeddings for Unseen Object Instance Segmentation" CoRL, 2021.



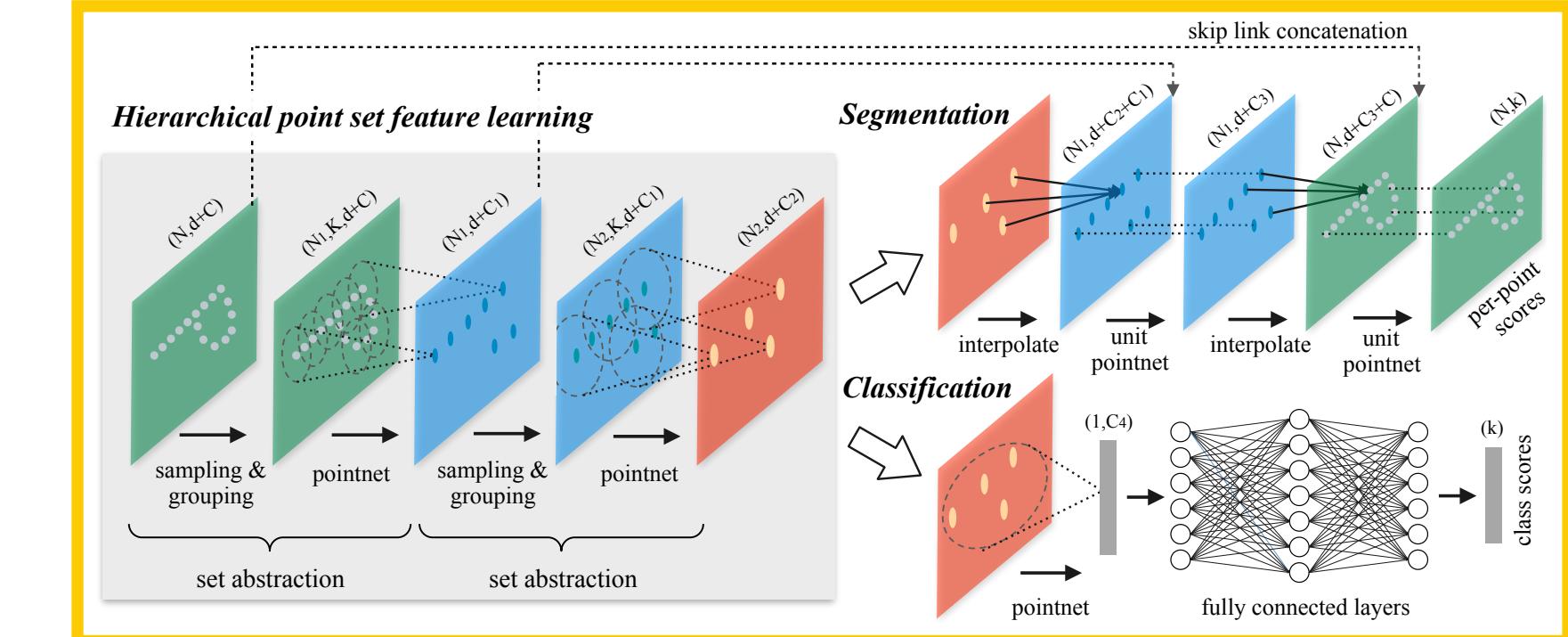
Pointcloud Processing

PointNet



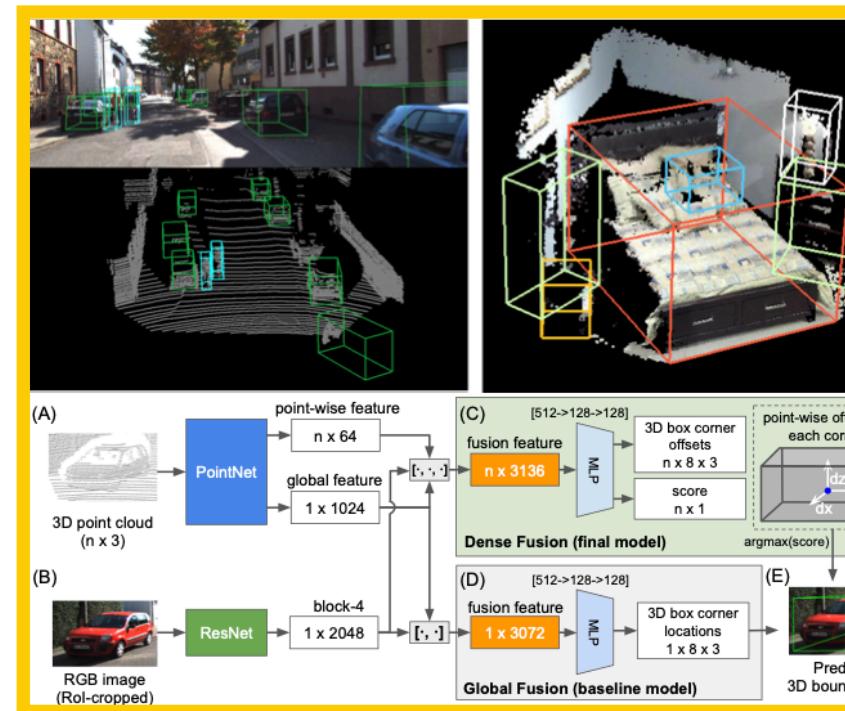
[1] Qi et al., CVPR 2017

PointNet++



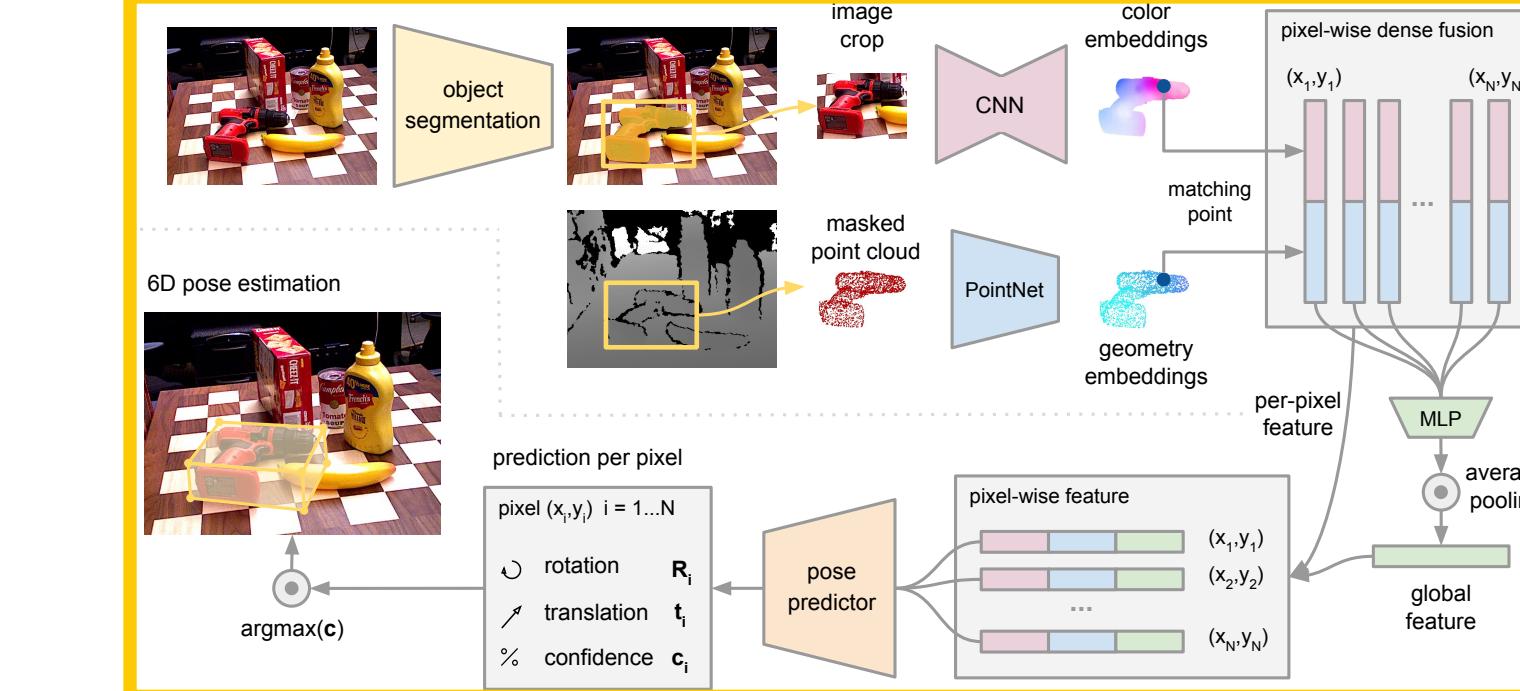
[2] Qi et al., NeurIPS 2017

PointFusion



[3] Xu et al., CVPR 2018

DenseFusion



[4] Wang et al., CVPR 2019

[1] Charles R. Qi, Hao Su, Kaichun Mo, Leonidas J. Guibas. "PointNet: Deep Learning on Point Sets for 3D Classification and Segmentation" CVPR, 2017.

[2] Charles R. Qi, Li Yi, Hao Su, Leonidas J. Guibas. "PointNet++: Deep Hierarchical Feature Learning on Point Sets in a Metric Space" NeurIPS, 2017.

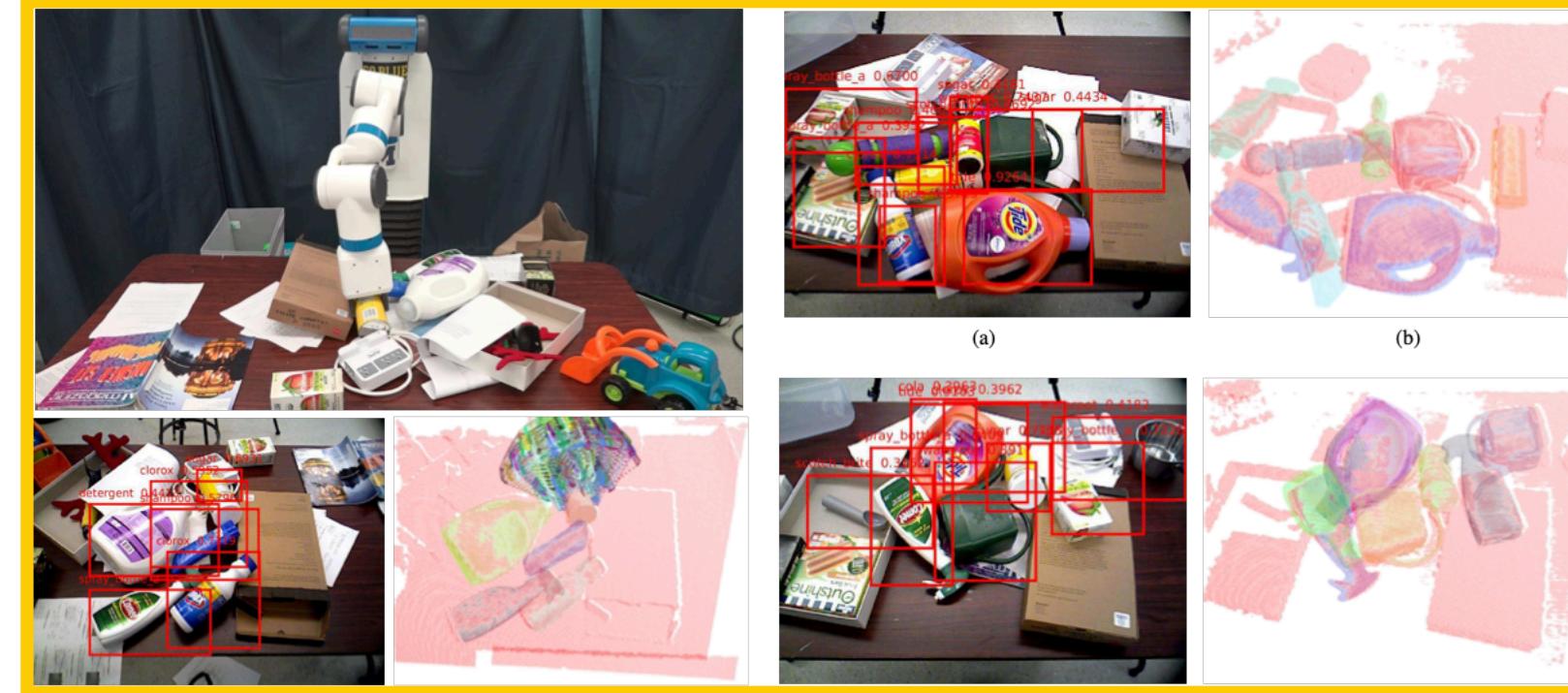
[3] Danfei Xu, Dragomir Anguelov, Ashesh Jain. "PointFusion: Deep Sensor Fusion for 3D Bounding Box Estimation" CVPR, 2018.

[4] Chen Wang, Danfei Xu, Yuke Zhu, Roberto Martín-Martín, Cewu Lu, Li Fei-Fei, Silvio Savarese. "DenseFusion: 6D Object Pose Estimation by Iterative Dense Fusion" CVPR, 2019.



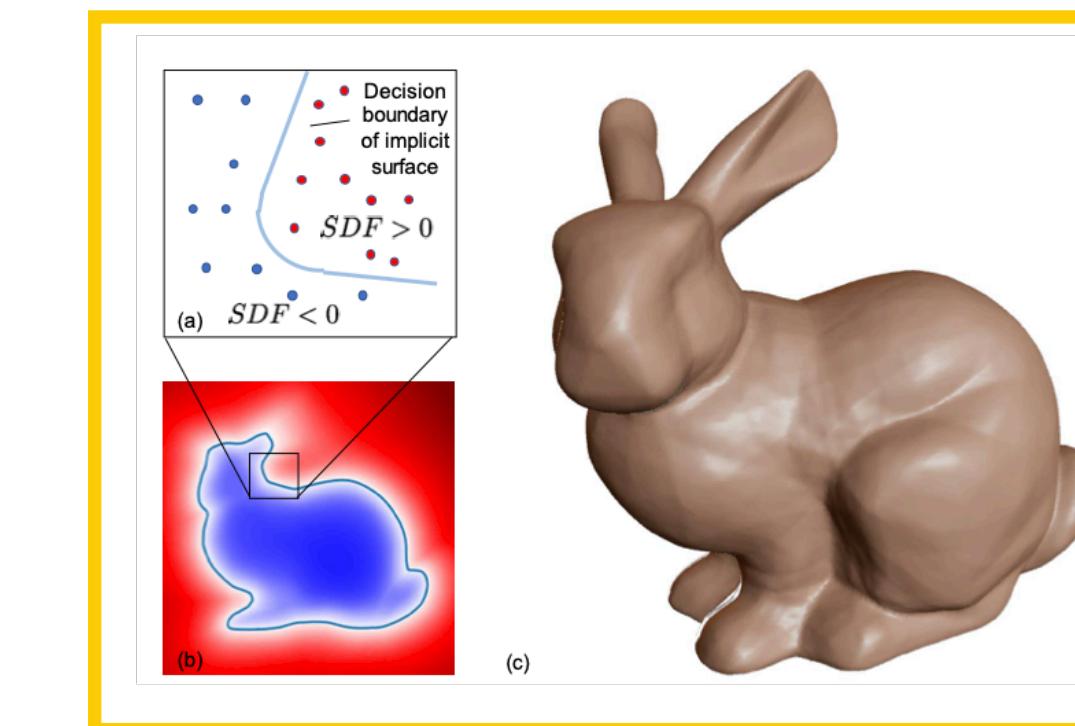
Object Pose, Geometry, SDF, Implicit Surfaces

Sequential Scene Understanding and Manipulation

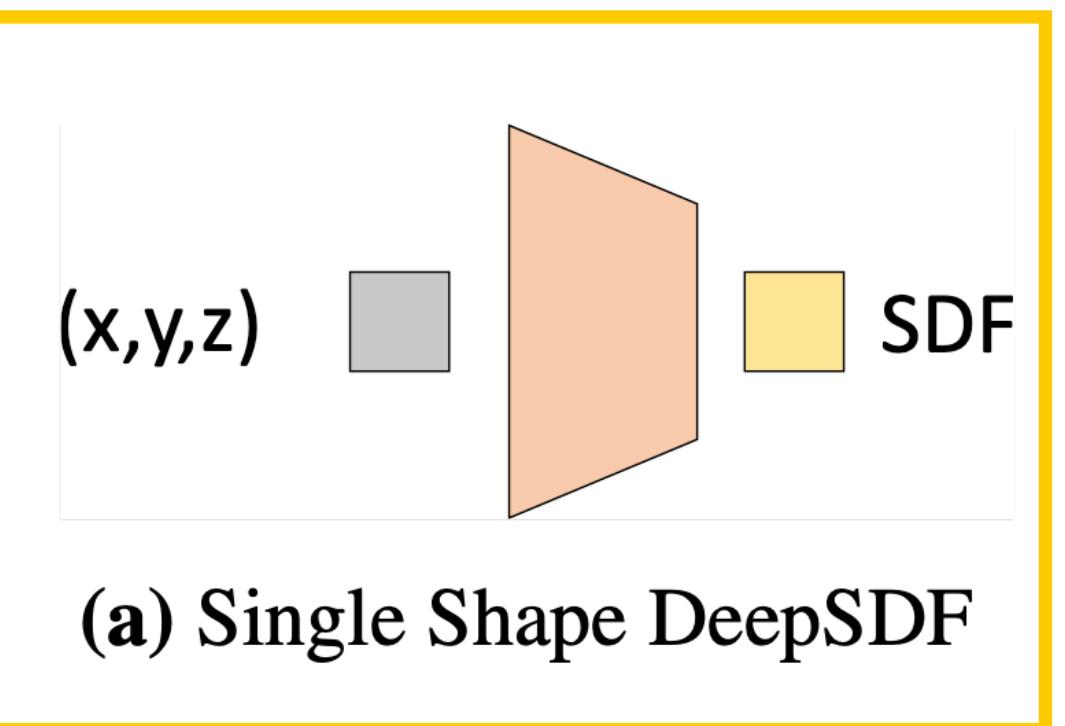


[1] Sui et al., IROS 2017

DeepSDF



[2] Park et al., CVPR 2019



(a) Single Shape DeepSDF

Implicit Surface Representations

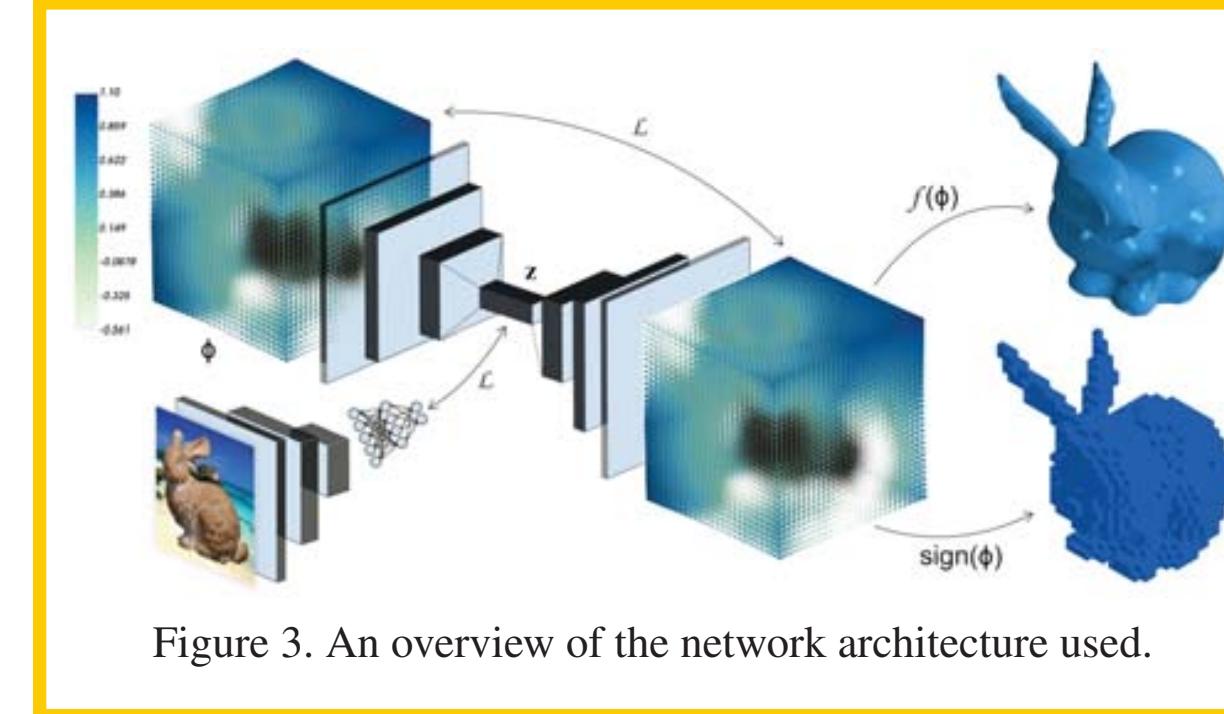


Figure 3. An overview of the network architecture used.

[3] Michalkiewicz et al., ICCV 2019



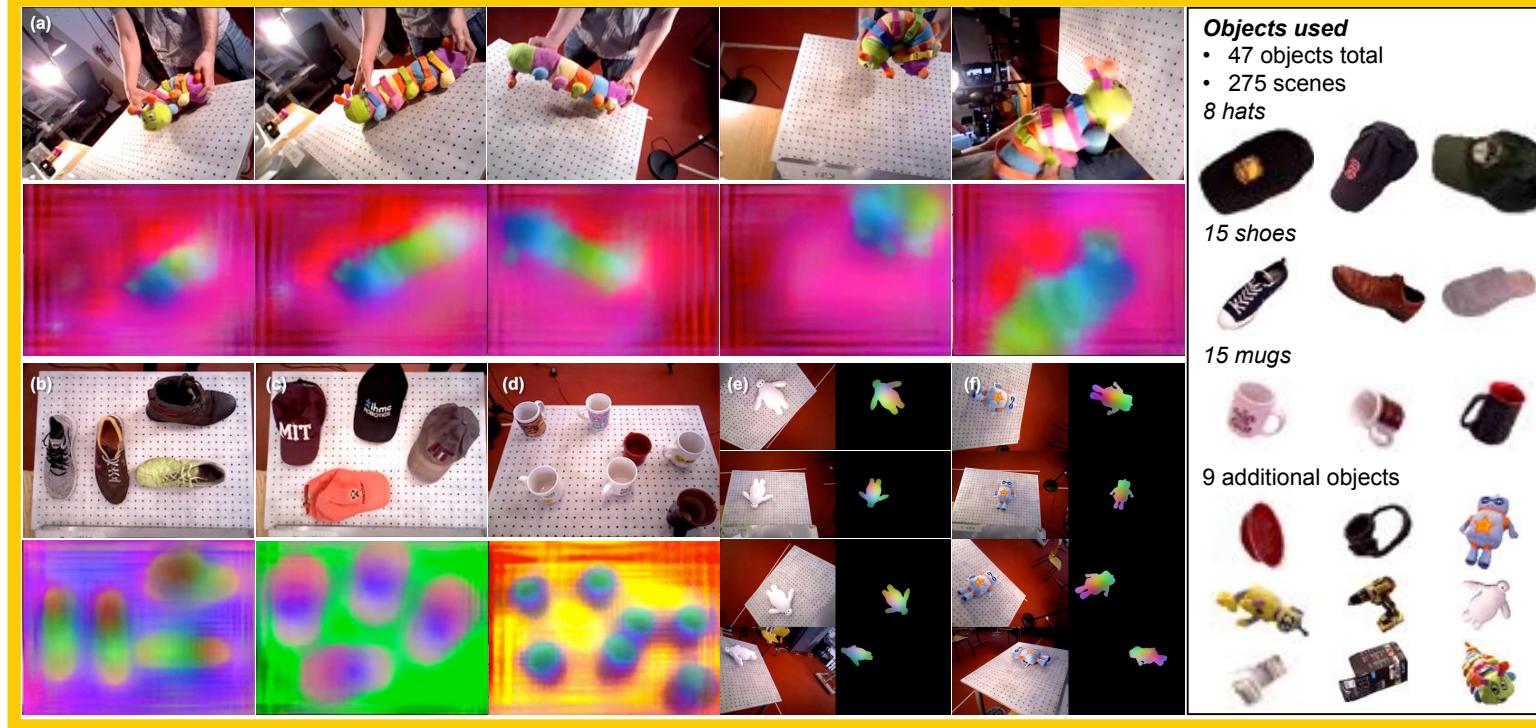
[1] Zhiqiang Sui, Zheming Zhou, Zhen Zeng, Odest Chadwicke Jenkins. "SUM: Sequential scene understanding and manipulation" IROS, 2017.

[2] Jeong Joon Park, Peter Florence, Julian Straub, Richard Newcombe, Steven Lovegrove. "DeepSDF: Learning Continuous Signed Distance Functions for Shape Representation" CVPR, 2019.

[3] Mateusz Michalkiewicz, Jhony Kaesemeyer Pontes, Dominic Jack, Mahsa Baktashmotlagh, Anders Eriksson. "Implicit Surface Representations As Layers in Neural Networks" ICCV, 2019.

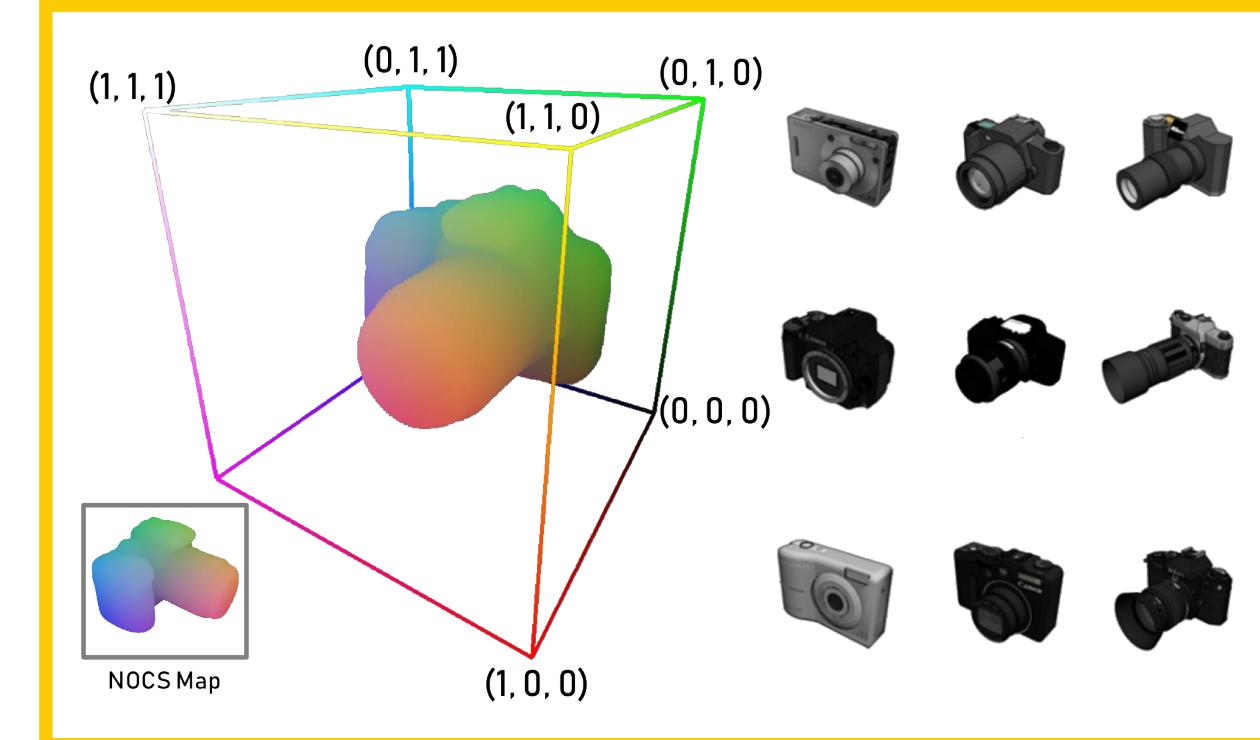
Dense Object Descriptors and Category-Level Representations

Dense Object Nets



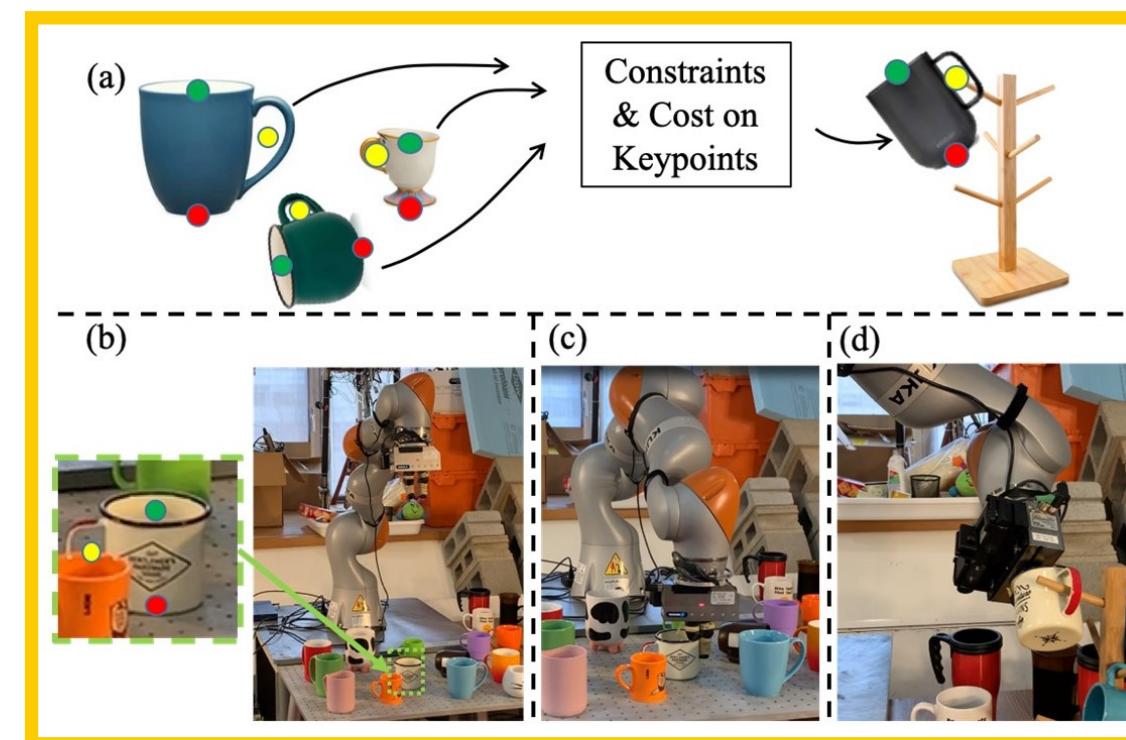
[1] Florence et al., CoRL 2018

NOCS



[2] Wang et al., CVPR 2018

kPAM



[3] Manuelli et al., ISRR 2019

Category-Level Pose from RGB



[4] Lin et al., ICRA 2022

[1] Peter R. Florence, Lucas Manuelli, Russ Tedrake. "Dense Object Nets: Learning Dense Visual Object Descriptors By and For Robotic Manipulation" CoRL, 2018.

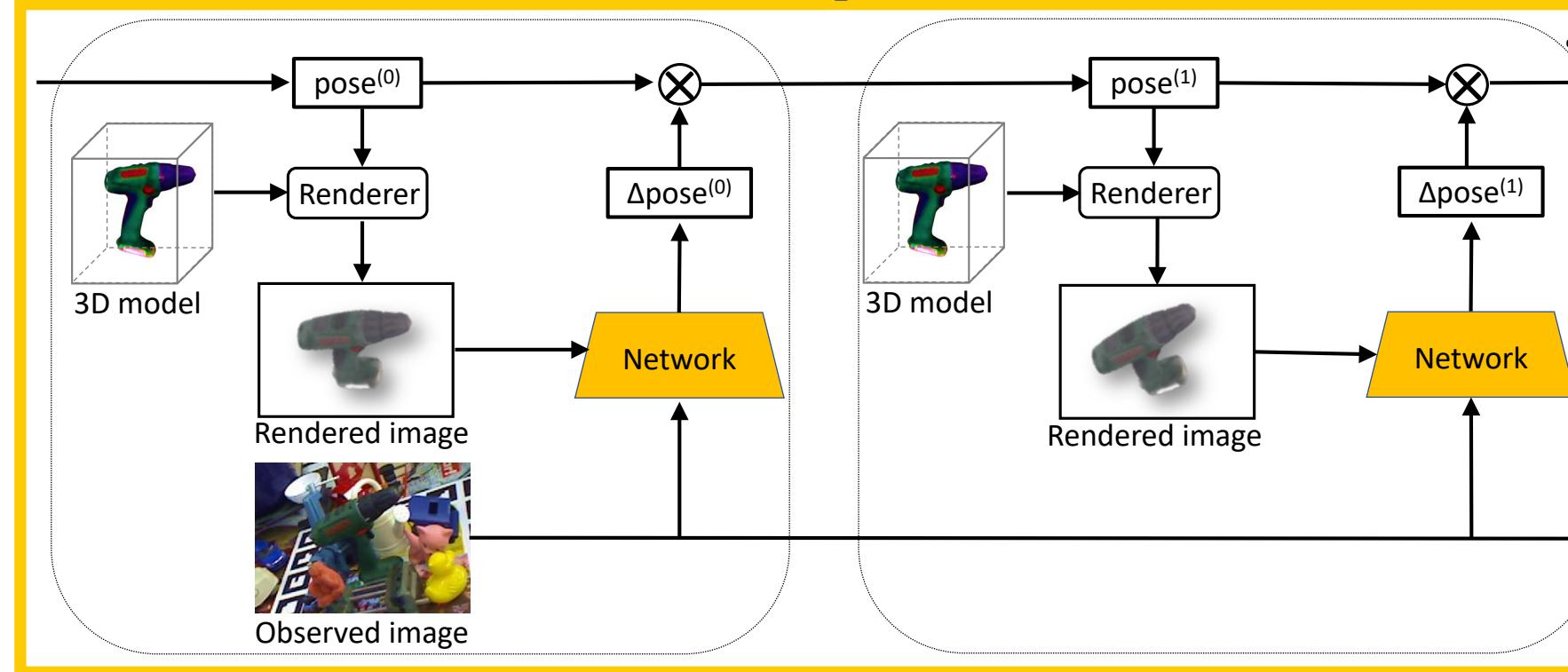
[2] He Wang, Srinath Sridhar, Jingwei Huang, Julien Valentin, Shuran Song, Leonidas J. Guibas. "Normalized Object Coordinate Space for Category-Level 6D Object Pose and Size Estimation" CVPR, 2019.

[3] Lucas Manuelli, Wei Gao, Peter Florence, Russ Tedrake. "kPAM: KeyPoint Affordances for Category-Level Robotic Manipulation" ISRR, 2019.

[4] Yunzhi Lin, Jonathan Tremblay, Stephen Tyree, Patricio A. Vela, Stan Birchfield. "Single-Stage Keypoint-Based Category-Level Object Pose Estimation from an RGB Image" ICRA, 2022.

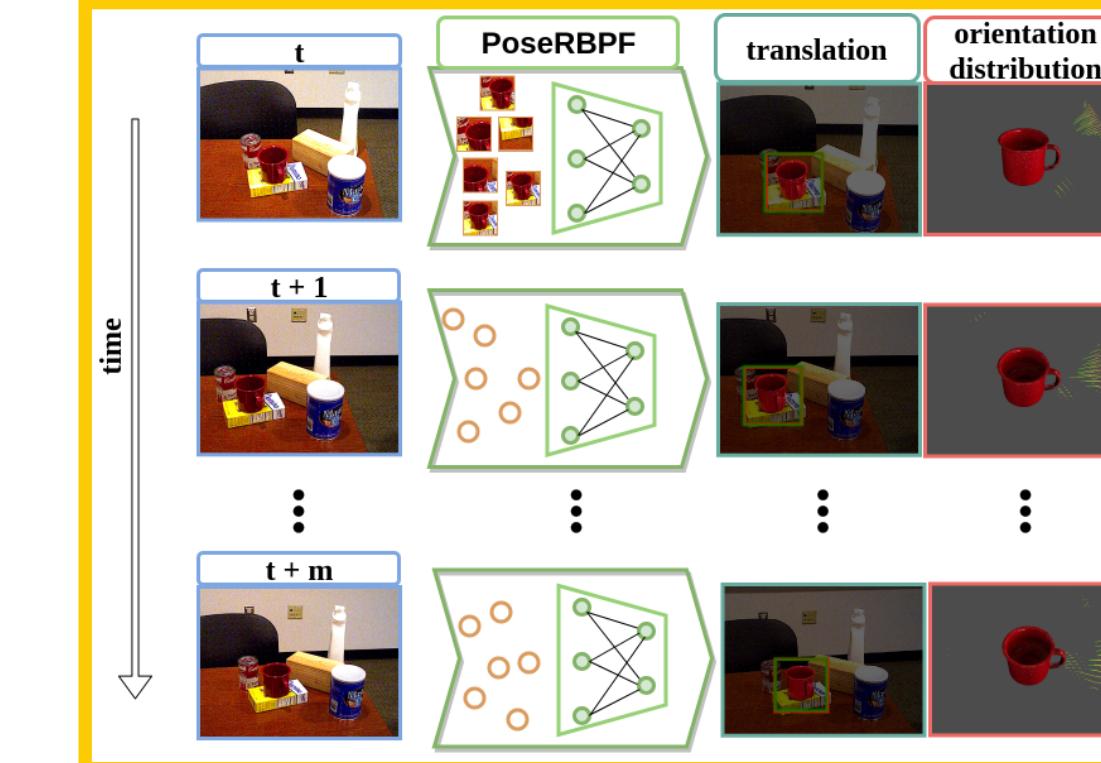
Recurrent Networks and Object Tracking

DeepIM



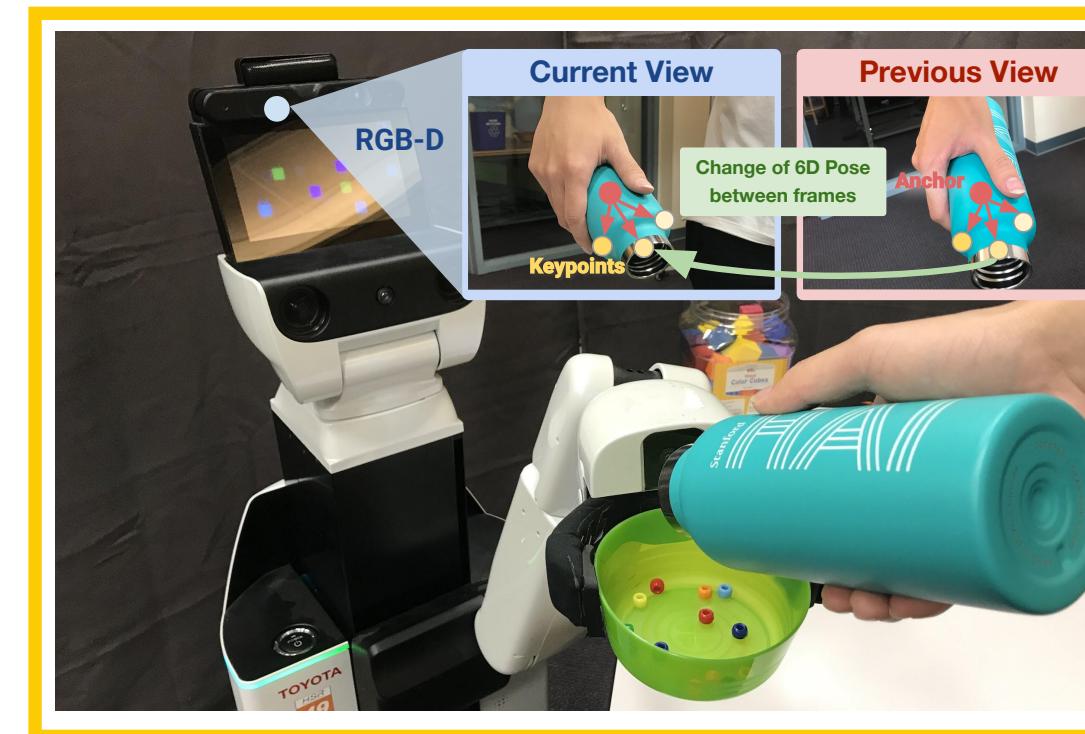
[1] Florence et al., CoRL 2018

PoseRBPF



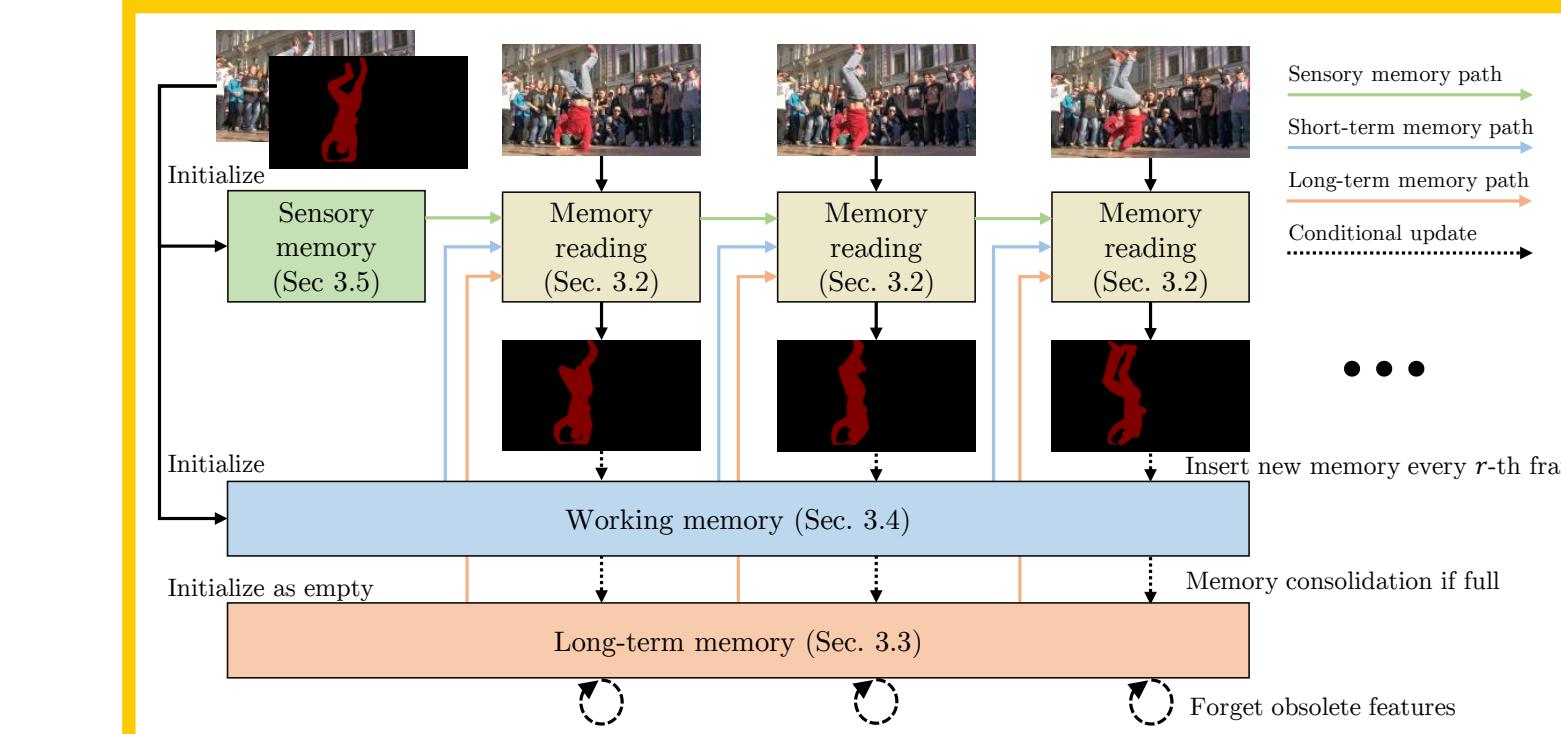
[2] Wang et al., CVPR 2018

6-PACK



[3] Manuelli et al., ISRR 2019

XMem



[4] Lin et al., ICRA 2022

[1] Yi Li, Gu Wang, Xiangyang Ji, Yu Xiang, Dieter Fox. "DeepIM: Deep Iterative Matching for 6D Pose Estimation" ECCV, 2018.

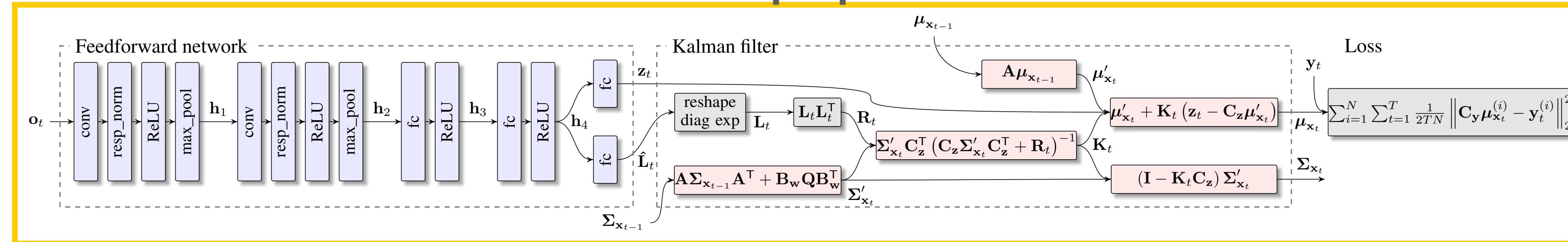
[2] Xinke Deng, Arsalan Mousavian, Yu Xiang, Fei Xia, Timothy Bretl, Dieter Fox. "PoseRBPF: A Rao-Blackwellized Particle Filter for 6D Object Pose Tracking" RSS, 2019.

[3] Chen Wang, Roberto Martín-Martín, Danfei Xu, Jun Lv, Cewu Lu, Li Fei-Fei, Silvio Savarese, Yuke Zhu. "6-PACK: Category-level 6D Pose Tracker with Anchor-Based Keypoints" ICRA, 2020.

[4] Ho Kei Cheng, Alexander G. Schwing. "XMem: Long-Term Video Object Segmentation with an Atkinson-Shiffrin Memory Model" ECCV, 2022.

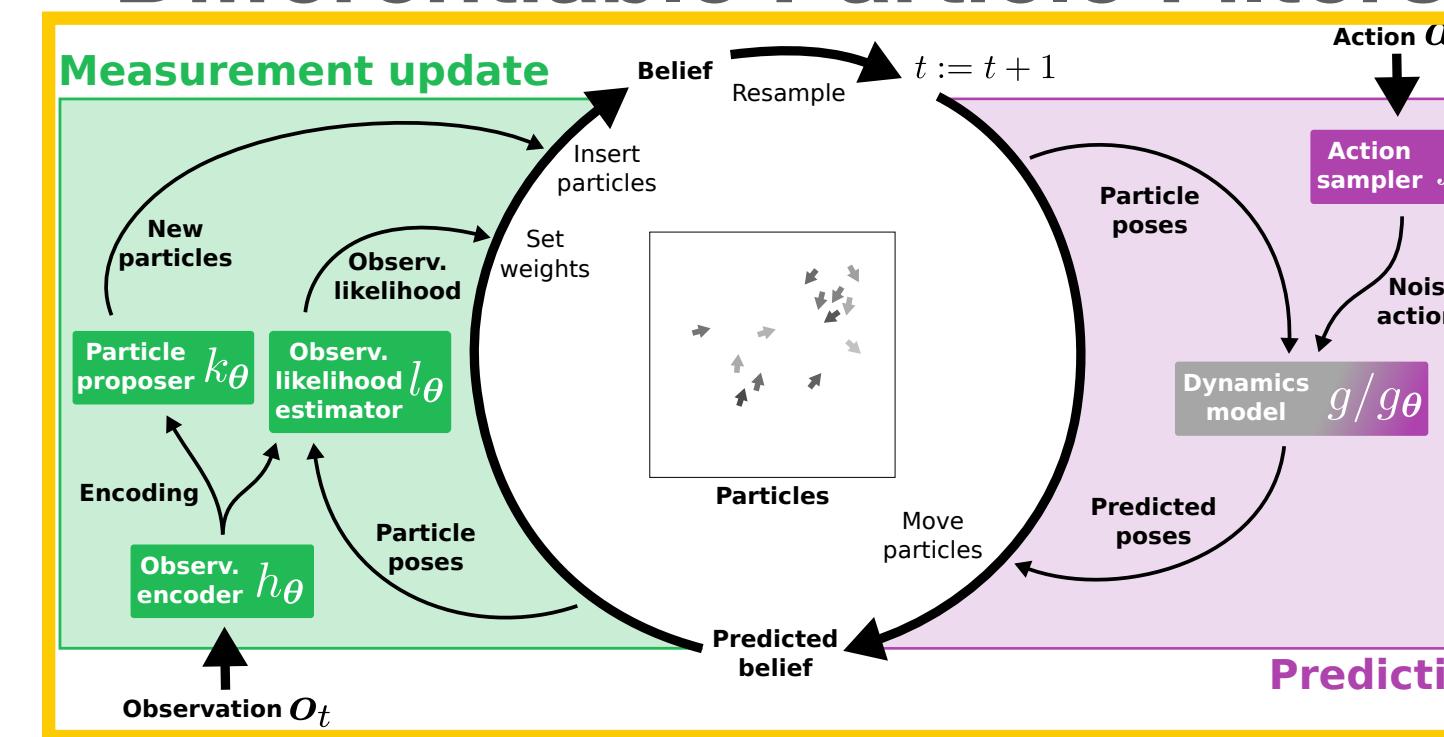
Visual Odometry and Localization

Backprop KF



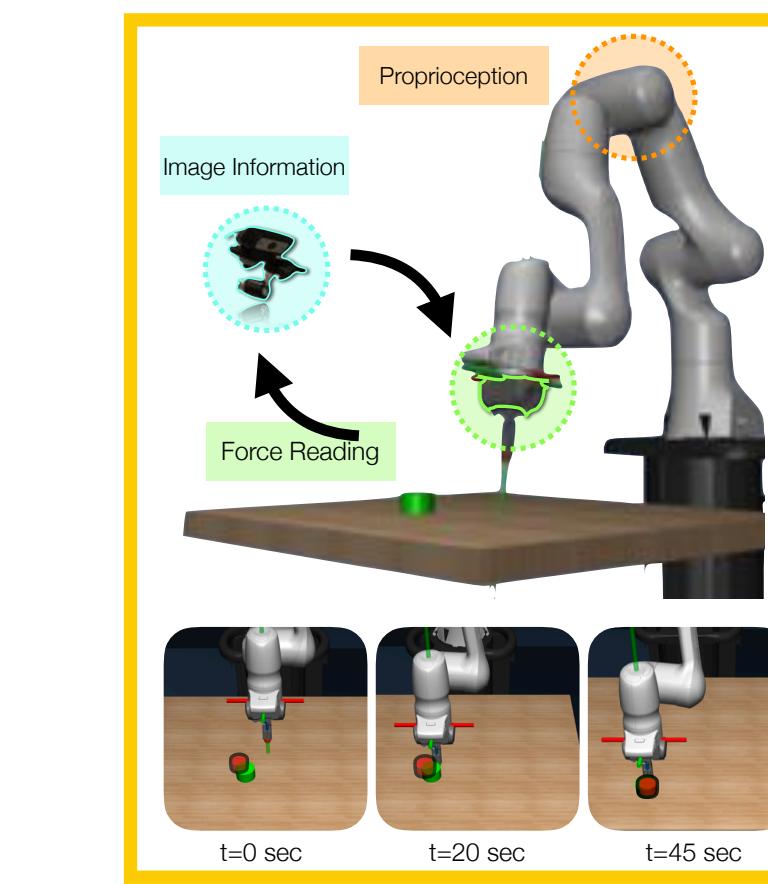
[1] Haarnoja et al., NeurIPS 2016

Differentiable Particle Filters



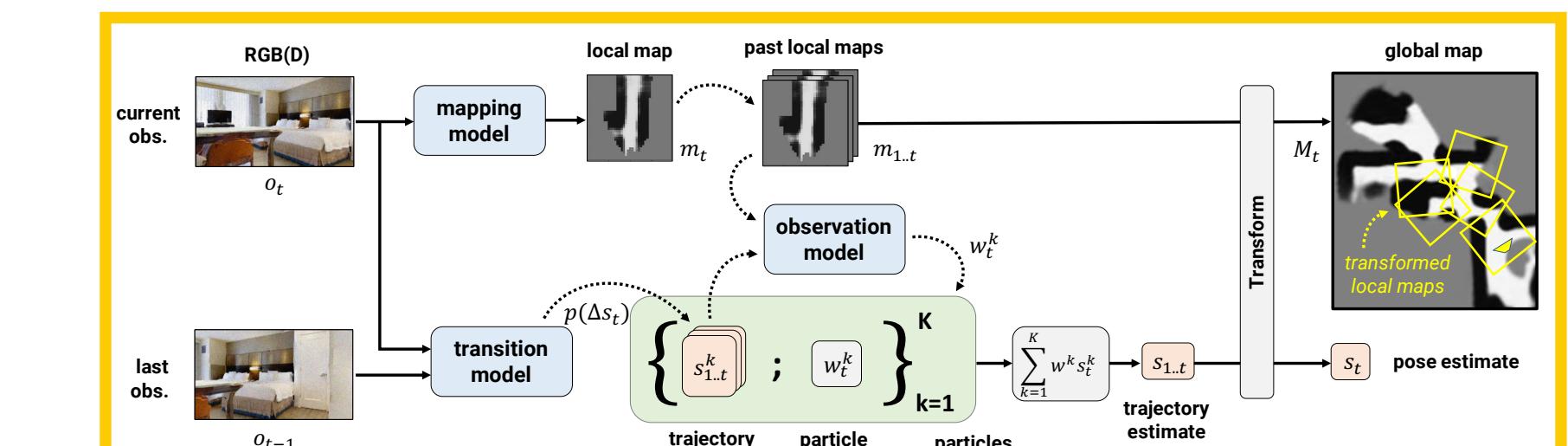
[2] Jonschkowski et al., RSS 2018

Multimodal Fusion



[3] Lee et al., RSS 2018

Differentiable SLAM-net



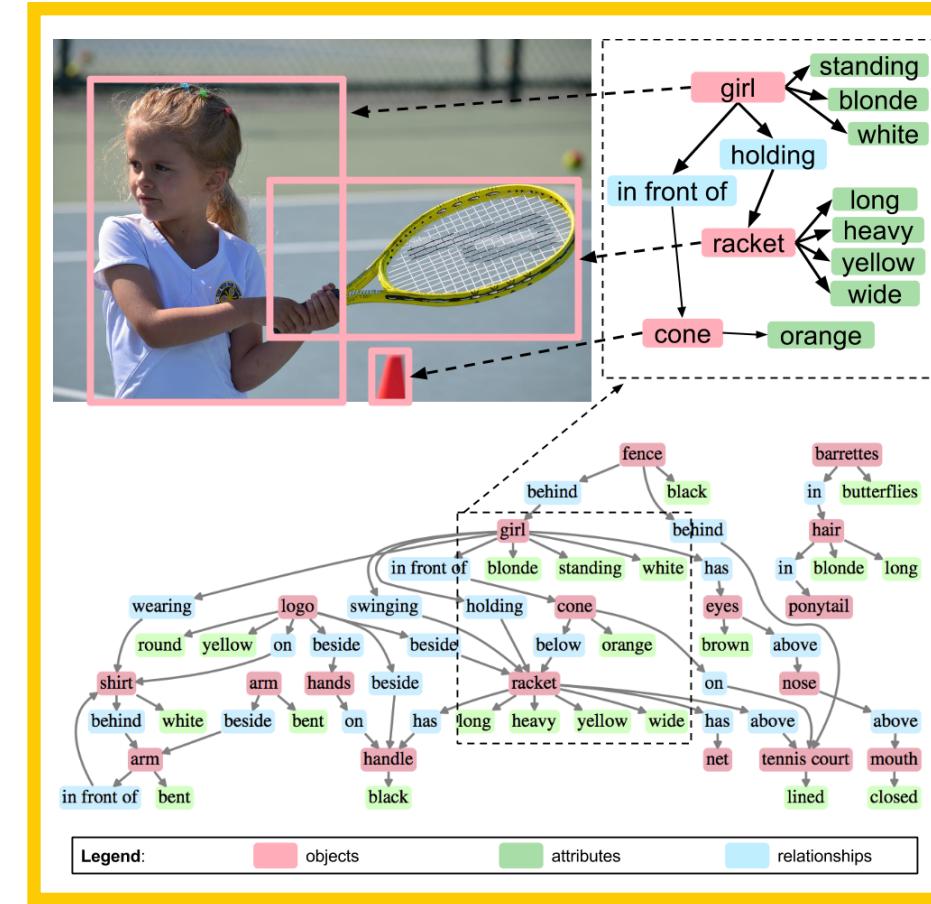
[4] Karkus et al., CVPR 2021



- [1] Tuomas Haarnoja, Anurag Ajay, Sergey Levine, Pieter Abbeel. "Backprop KF: Learning Discriminative Deterministic State Estimators" NeurIPS, 2016.
- [2] Rico Jonschkowski, Divyam Rastogi, Oliver Brock. "Differentiable Particle Filters: End-to-End Learning with Algorithmic Priors" RSS, 2018.
- [3] Michelle A. Lee, Brent Yi, Roberto Martín-Martín, Silvio Savarese, Jeannette Bohg. "Multimodal Sensor Fusion with Differentiable Filters" IROS, 2020.
- [4] Peter Karkus, Shaojun Cai, David Hsu. "Differentiable SLAM-net: Learning Particle SLAM for Visual Navigation" CVPR, 2021.

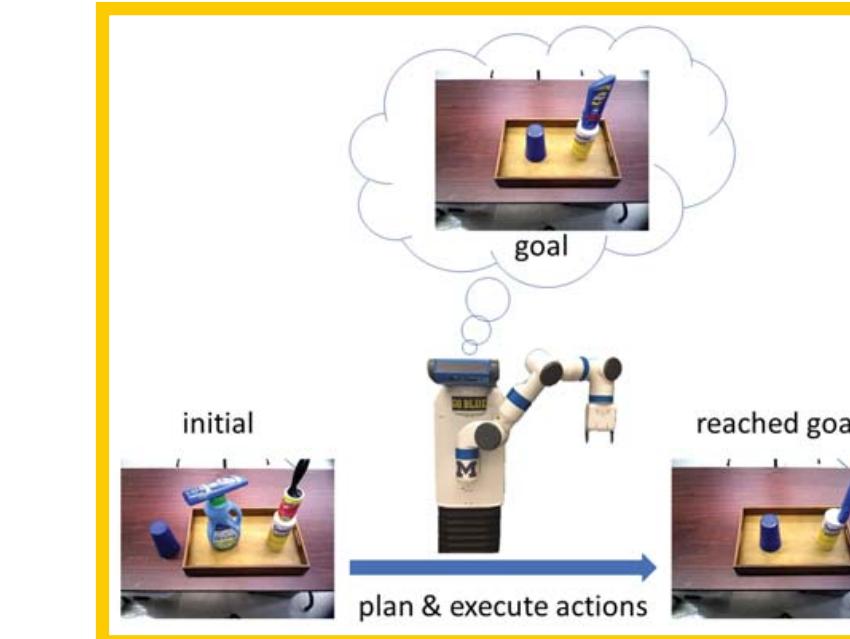
Semantic Scene Graphs and Explicit Representations

Image Retrieval using Scene Graphs



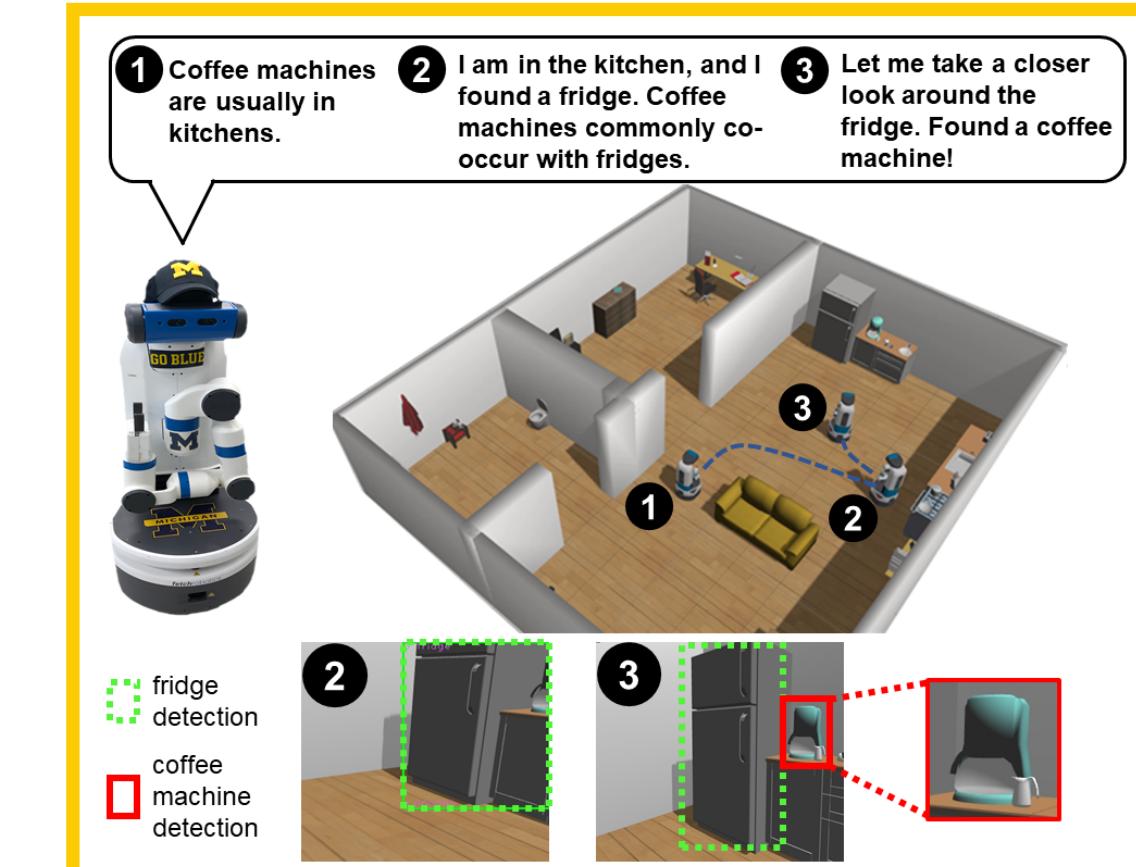
[1] Johnson et al., CVPR 2015

Semantic Robot Programming



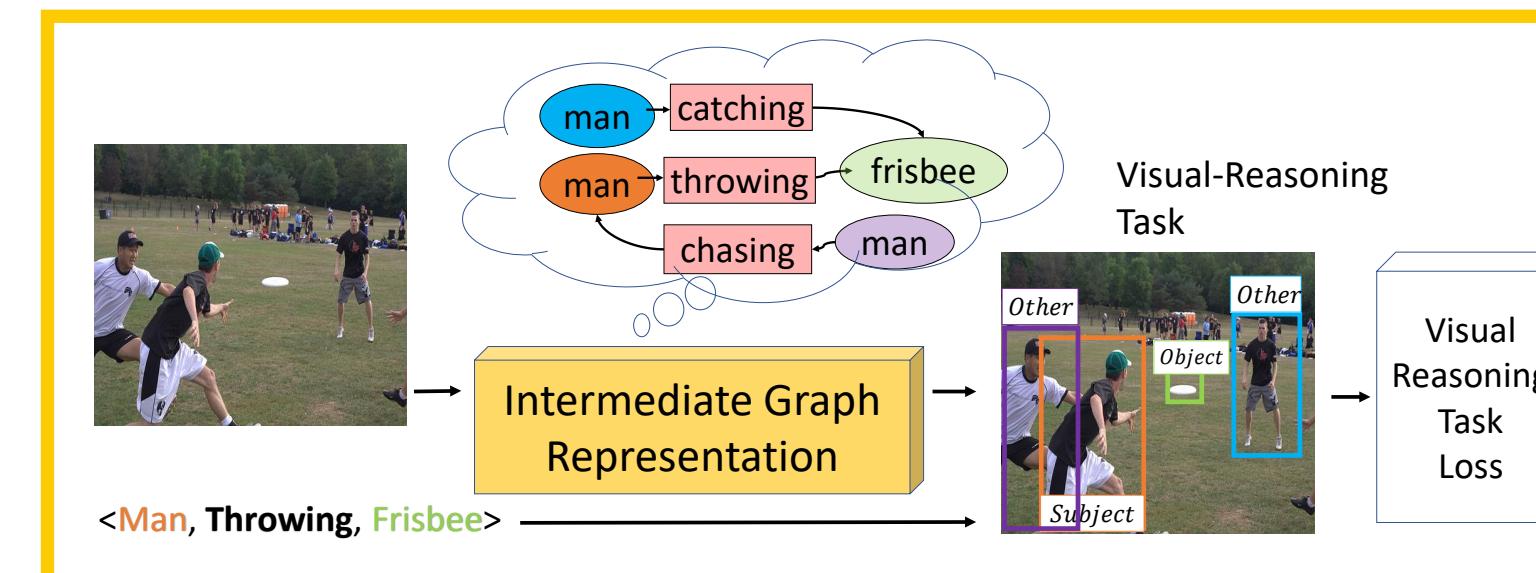
[2] Zeng et al., ICRA 2018

Semantic Linking Maps



[4] Zeng et al., ICRA 2020

Differentiable Scene Graphs

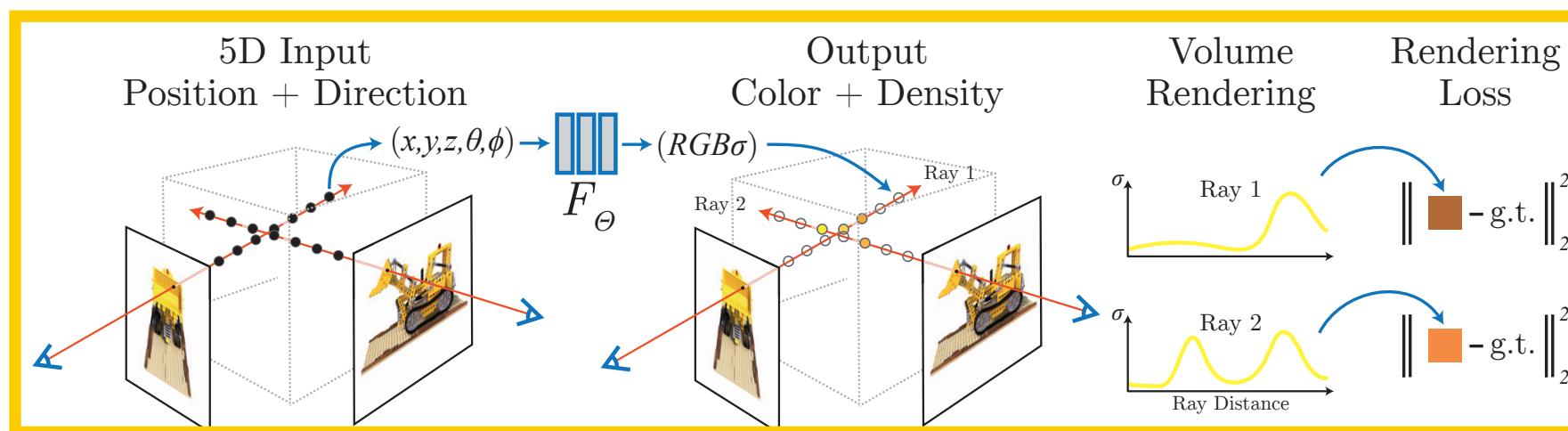


[3] Raboh et al., WACV 2020



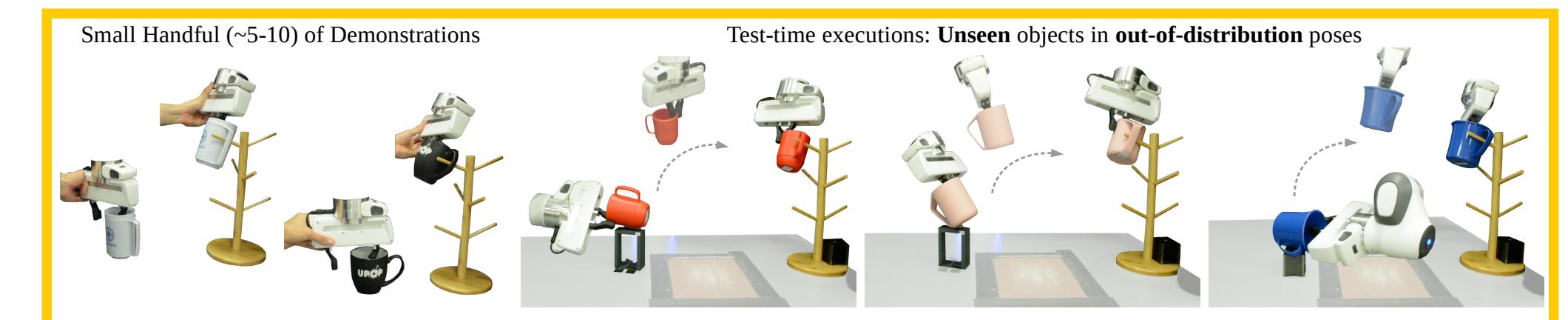
Neural Radiance Fields and Implicit Representations

NeRF



[1] Mildenhall et al., ECCV 2020

Neural Descriptor Fields



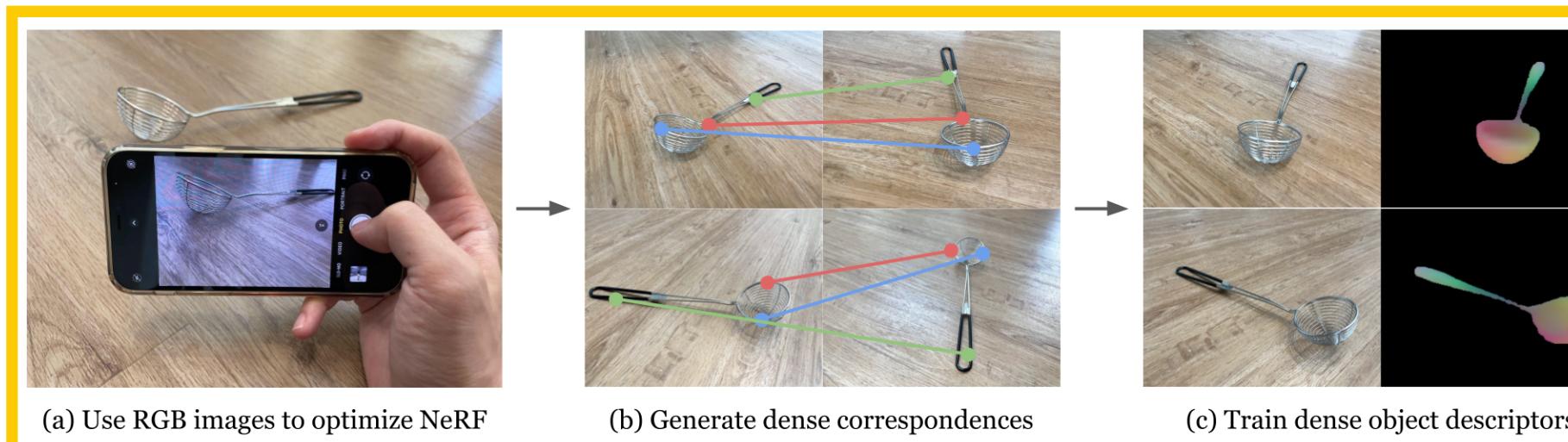
[3] Simeonov et al., ICRA 2022

Object-Centric NeRFs



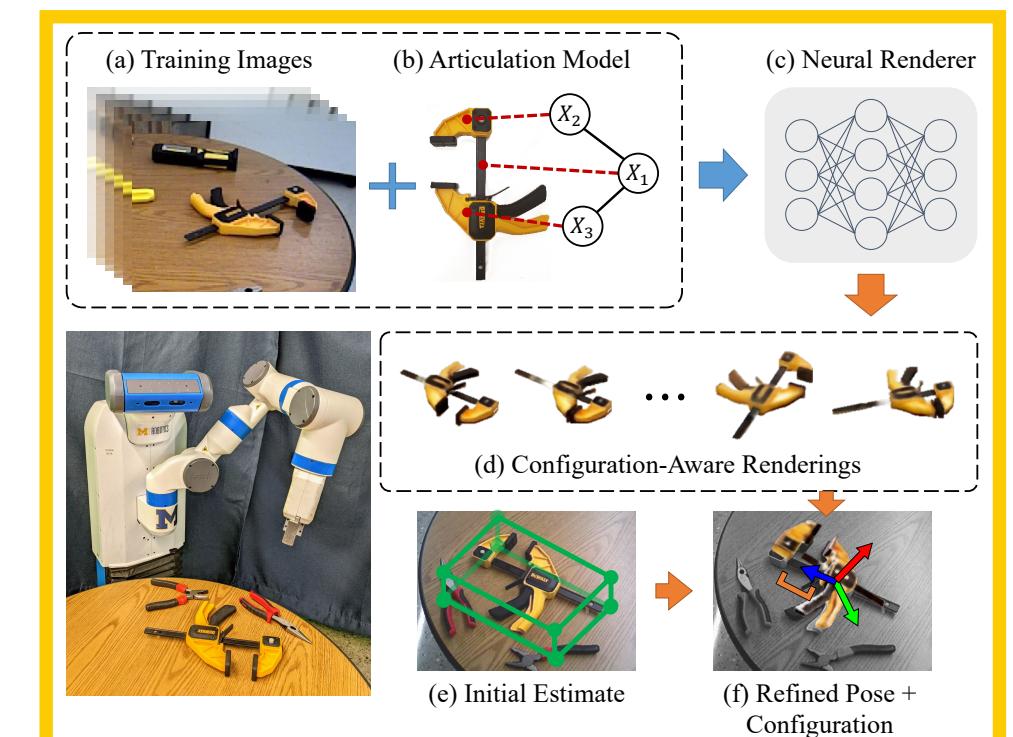
[2] Guo et al., 2020

NeRF-Supervision



[4] Yen-Chen et al., ICRA 2022

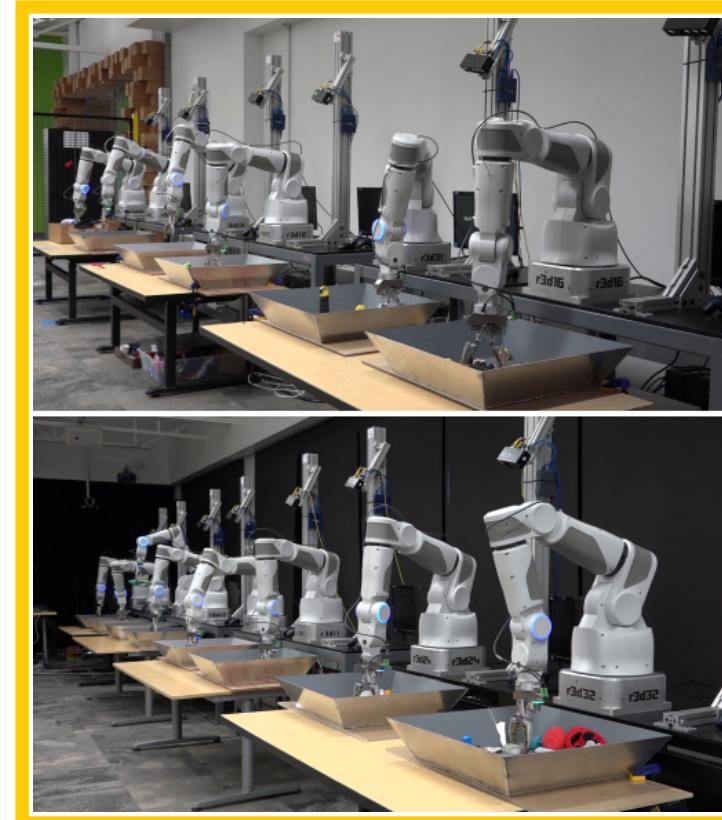
NARF22



[5] Lewis et al., IROS 2022

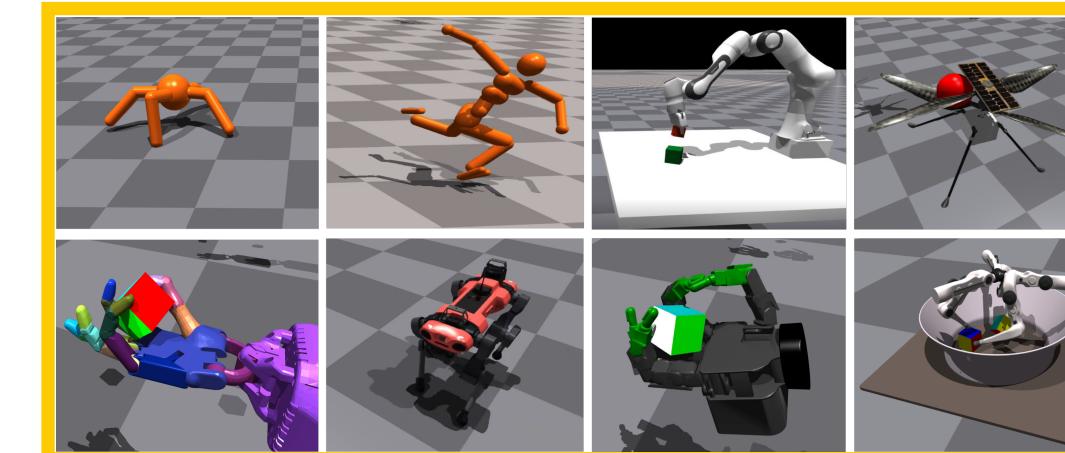
Datasets

Large-Scale Data Collection with Robots



[1] Levine et al., IJRR 2018

Simulating Robot Datasets



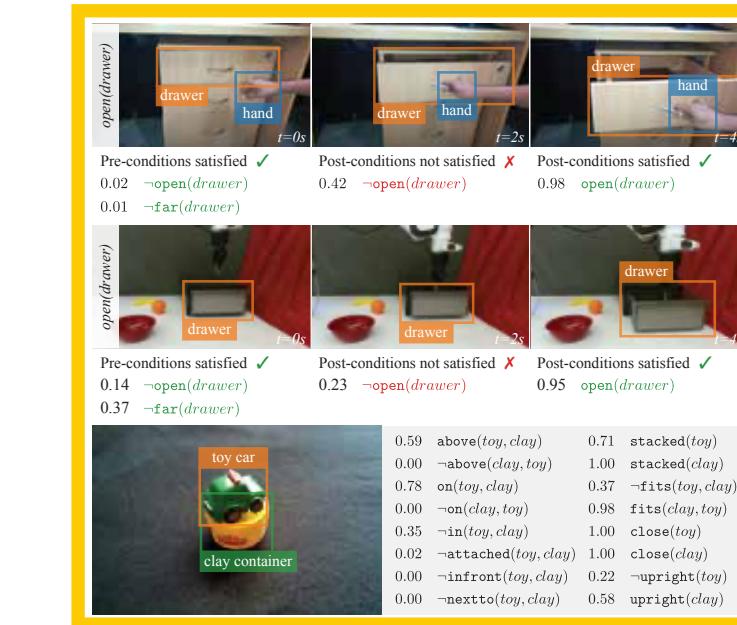
[2] Makoviychuk et al., 2021

All You need is LUV



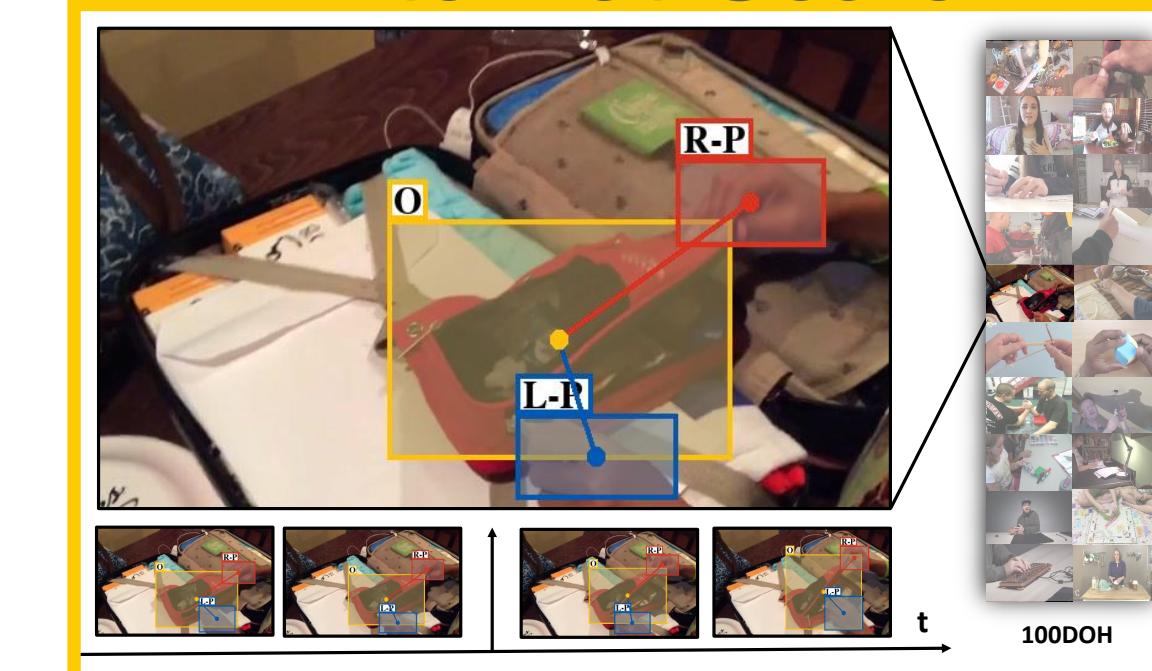
[4] Thananjeyan et al., IROS 2022

Grounding Predicates through Actions



[3] Migimatsu and Bohg, ICRA 2021

Internet-Scale



[5] Shan et al., CVPR 2020

Even More!

- Grasp Pose Detection
- Tactile Perception for Grasping and Manipulation
- Transformer Architectures
- Deformable Object Representations
- Interpretable Models